Fire Study of the Foresthill Divide Community Plan Area

June 14, 2011

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INTRODUCTION

AREA DESCRIPTION

The town of Foresthill is approximately 50 miles north-east of Sacramento along Interstate 80. Located between the North and Middle Forks of the American River, Foresthill was originally established as a gold mining community in 1850. As the gold rush slowed, logging became a primary source of income for the miners. Mills were established all over Foresthill. This industry too became costly, and individuals began working outside of Foresthill in areas like Auburn and Sacramento. Although mining and timber harvesting are no longer the primary source of income in the community, many of the residents continue to commute daily to Auburn and even Sacramento for work. Foresthill Road is the primary road for residents commuting to and from Foresthill. Approximately 6,000 people live in Foresthill. Other towns in the study area include Todd Valley and Michigan Bluff, which include approximately 1,000 more individuals.

Foresthill Divide is a ridge that separates the North and Middle Forks of the American River. The topography of the area is complex, ranging from approximately 600 feet above sea level to 5,500 feet along the eastern boundary. With complex terrain comes complex vegetation and weather systems. Some areas have chaparral, montane hardwood conifer, black oak, and incense cedar, while others are dominated by ponderosa pine, Douglas fir and white fir. Winters in Foresthill can be cold; lows average 35°F. The average high in December and January are 55° and 56° F, respectively. July is typically the warmest month, with average highs in the 90s. Most of the precipitation comes between November and March, peaking in January with 8.77 inches. The summers are typically dry, and July receives less than 0.2 inches of precipitation on average.[1]

Following the December 2009 revision and adoption of the Forest Hill Community Plan, two community groups, Foresthill Residents for Responsible Growth, Inc. (FROG) and Friends of the North Fork (Friends), filed a CEQA claim, challenging the adequacy of the environmental analysis and requiring a review of fire/emergency services. As part of a legal agreement, the county was tasked with contracting a third party consultant to review the existing emergency service plans to evaluate the efficacy of existing emergency and evacuation plans. Through dialogue with local fire and emergency services personnel, the most likely fire scenarios that could affect the Plan Area were discussed. Fires were ignited in predetermined places and let burn, unsuppressed, for eight hours in several simulated computer models. Using the results of the models, Anchor Point was able to evaluate the potential impact fire could have on the area.

FIRE HISTORY

Within Foresthill, CAL FIRE and the USFS are the primary agencies responsible for wildland fire suppression. The Foresthill Fire District provides mutual aid. The majority of fires in the area come from human ignitions, especially along Foresthill Road. Motor vehicle accidents and ignitions from equipment are most common. According to the 2005 ERT, lightning accounts for less than 15% of the large fires.[2]

[1] "Average Weather for Foresthill, CA – Temperature and Precipitation," 8 June 2011. <http://www.weather.com/outlook/health/fitness/wxclimatology/monthly/graph/USCA0390>.

[2] Steve Holl Consulting, "West Slope Sierra Nevada Placer County CWPP," March 2008: 2-5.

The majority of the fires that impact the community occur in the valley below Forest Hill Divide, especially in the southwestern tip of the Community Plan Area. There have not been many significant fires actually on the divide, and fires rarely spread from the river valley to the communities above. There have been large fires in the vicinity of Foresthill, but none have directly impacted the town in the last 50 years.

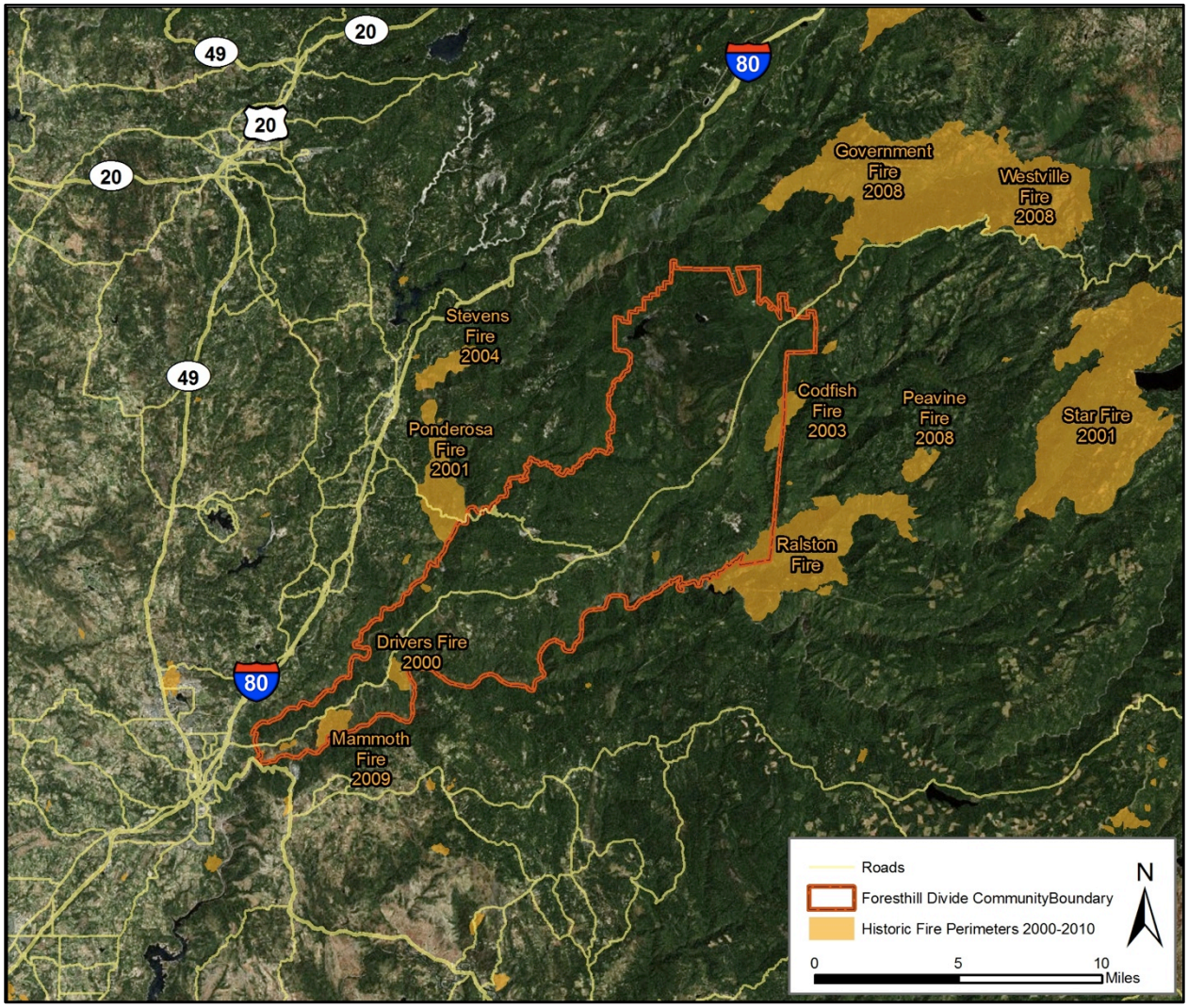

Figure 1. Perimeters of fires within the study area over the last 10 years.

Second to humans, lighting is a common cause of *small* fires in the area during the summer months. During these storms, a single tree is generally struck along a ridgeline. Fires occurring at the top of a peak or along a ridgeline are typically wind-driven events, but since there is a fairly dense forest, the wind is greatly reduced, thus reducing rates of spread and fire size.
Camping and other recreational activities are typically responsible for the fires that begin along the American River. Because of the vegetation type and steep slopes, fire can move quickly from the river up to the canyon rim. Prolonged drought in combination with an ignition source, and hot, dry conditions could result in a faster moving fire that could cover a large area.

RESULTS & DISCUSSION

OVERVIEW OF FIRE BEHAVIOR IN PROJECT AREA

The higher elevations within the community area experience greater rain and snowfall than the lower elevations to the southwest. As a result, the wildland fuels are not as dry and do not typically produce extreme fire behavior. The probability of ignition is lower, and so is the rate of spread (ROS). The ground is typically shaded by large ponderosa pines with Douglas fir in the understory, so surface fuels on the forest floor remain moist. There is a separation of the overstory canopy and understory vegetation that reduces the potential for fire spreading into the tree canopies and transitioning to torching or active crown fire. The slopes are gradual to almost flat, which slows fire spread and lessens flame lengths.

In contrast, the lower elevations are drier and windier. The fuels are primarily grass and shrubs that are not sheltered from the wind and will allow for rapid fire spread. Chaparral vegetation, found on the steep slopes along the canyons west of the Middle Fork of the American River is of particular concern because the associated shrubs have volatile oils that burn extremely hot and can burn intensely. Rates of spread are between 2-4 miles per hour and flame lengths are predicted to reach 40 feet or more as the fire burns through the canopy of these dense shrubs.

The predominant wind direction in the study area is southwest and influenced by the river corridors. This means that fires initiating in the study area are pushed in a northeast direction. While wind has an impact on the direction and rate of spread, topography also has a large influence on fire spread. A fire starting at the bottom of a steep slope preheats the fuels further up the slope, drying them out and making them more susceptible to burning. As a result, fire has the potential to travel rapidly uphill. This pattern is typical of the area, and the combination of wind and topography has been observed on many of the fires that have burned near Foresthill.

ANALYSIS

The study area was analyzed using three different modeling methodologies. (See Appendix A for a more detailed explanation on the methodologies.) The modeling was based on an extreme fire weather day with winds blowing uphill at 20 miles per hour (identical to the Auburn or 49 Fire, which started on August 30, 2009). The fires were set to burn for four hours without any suppression activities in Analysis Two and Three. It should be noted that these conditions are rare and more likely to be experienced in the valleys than on the Divide. In addition, it would be rare for a fire to burn freely without suppression efforts for more than 30 minutes in this area. The base layer that is used for modeling does not account for structures, type of home construction, road types, widths, and other man made features and hazards. These can affect both the rate and behavior of the fire and evacuation efforts.

Analysis One: FlamMap

Predicted fire behavior using the fire weather parameters mentioned above was modeled on the entire study area on a cell-by-cell basis. This assumes that every cell is ignited and does not depend on time. This allows for comparison of all areas under identical environmental conditions. This method is best for looking at the adequacy of the evacuation centers since it predicts an ignition in the cells that surround the structure. Fuels reduction prescriptions can be written to mitigate areas of concern.

Although eight evacuation centers are identified, three are recommended for use as shelters for 24-48 hours. These centers and associated lands are similar to safety zones used in wildfire suppression. A safety zone is defined as an area where an individual can survive without any additional protection from the fire. A formula is used to calculate the minimum area needed to be safe from the radiant intensity of the heat generated from a given flame length (Table 1).[3]

Flame Height (ft)	Separation Distance (firefighters to flames, ft)	Minimum Area Needed (acres)
10	40	1/10
20	80	1/2
50	200	3
100	400	12
200	800	46

Table 1. Required safety zone areas given specific flame lengths.

The flame lengths around the centers listed below were a maximum of 11 feet. If the trees around these buildings were to torch then they would have 50-60 foot flame lengths. Using the table above, a 3-acre radius is needed for a worst-case scenario. The acreages of the evacuation centers listed below are larger than the required minimum area and would be a safe place to shelter if proper mitigation and defensible space were implemented.

Evacuation Center	Approximate Acreage
Foresthill High School/Old GP Mill Site	105
Foresthill Middle School	12
Foresthill Elementary School	6

Table 2. Acreages of identified evacuation centers.

This landscape analysis is also useful for evaluating fuel break treatment projects that have been completed in the study area. There was a drastic decrease in flame lengths and rates of spread where fire was modeled over the existing shaded fuel breaks. Additionally, the fuel breaks reduce the chance of crown fire initiation.

[3] Incident Response Pocket Guide, January 2010, pg. 7

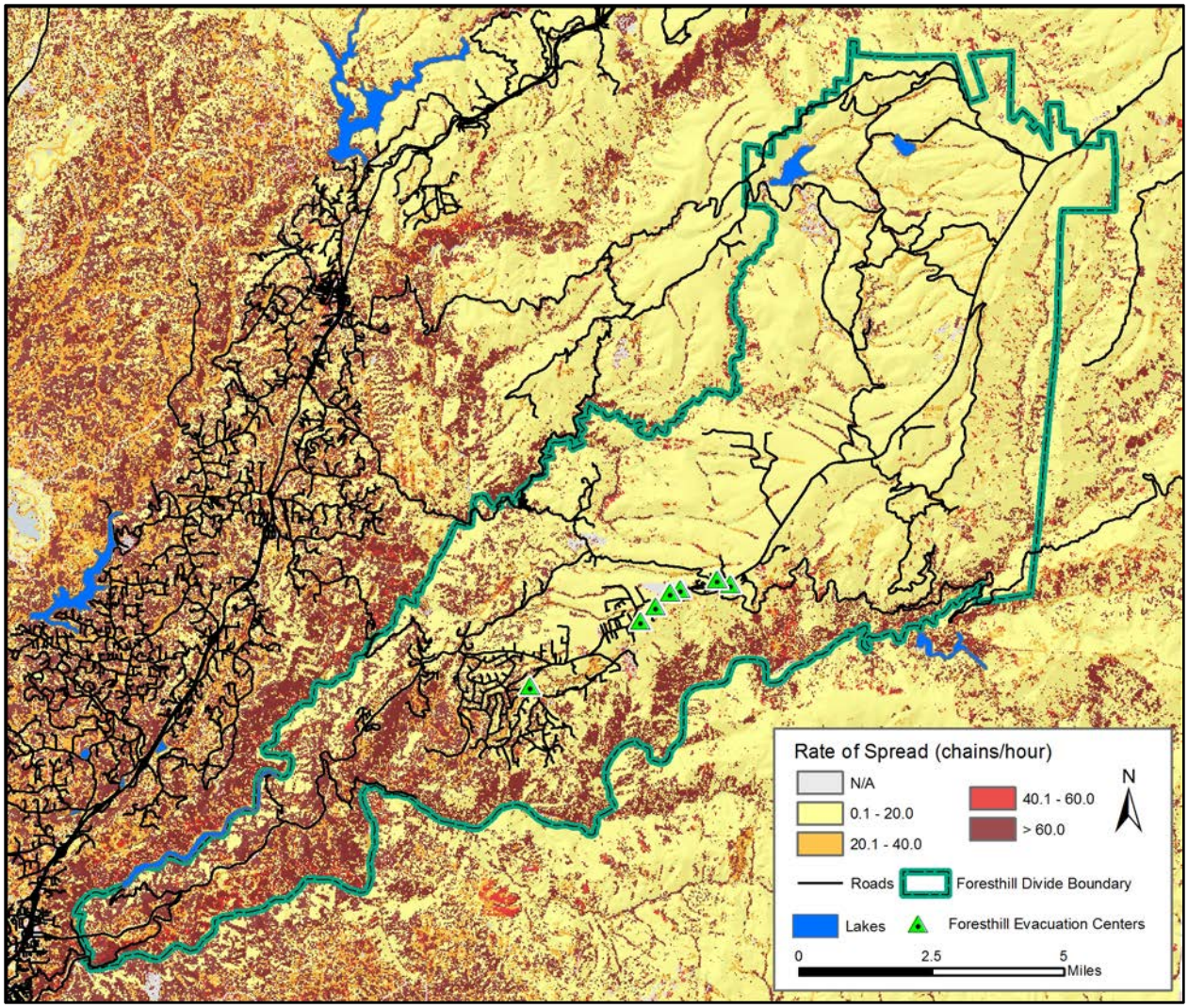

Figure 2. Predicted rates of spread from FlamMap model using extreme weather inputs.

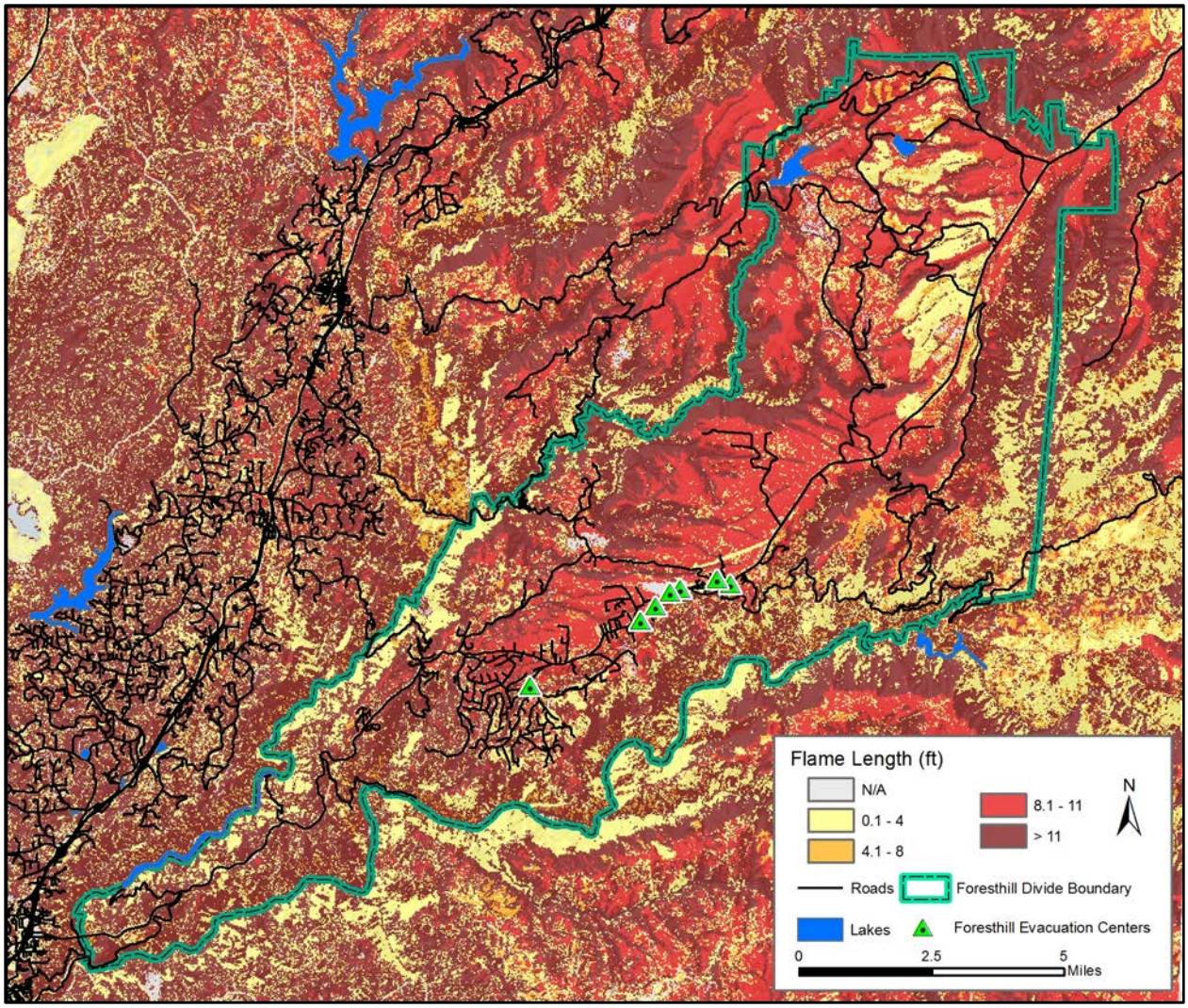

Figure 3. Predicted flame lengths from the FlamMap model, using extreme weather inputs.

Analysis 2: FARSITE

Seven ignition points were modeled using the extreme fire weather parameters mentioned above. The first name of the points represents the value at risk that is threatened, while the second name is the location of the ignition source. The fires were set to burn for four hours without any suppression activities. These ignitions were chosen because they are believed to be areas where recreational use may increase the probability of a fire start and/or because the values at risk that are threatened. The time of arrival (TOA) outputs were overlaid onto the landscape to show their predicted impact.

The Devil's Canyon ignition shows minimal fire activity. In the mixed conifer/pine forest the fire slows down drastically due to wind-sheltering and the north-facing slope that is typically wetter. If left to burn the fire would reach a band of shrubs that would have higher flame lengths and faster rates of spread. Ember spotting would be expected as the fire reaches the rim as a result of being exposed to the ridge top winds. The fire would not reach the rim until being allowed to burn unhindered for four hours. This scenario would allow time to evacuate the Yankee Jims area to Foresthill Road.

Both ignitions modeled on top of the divide (Blackhawk Road and Thomas Road) moved uphill to the northeast at a slow rate of spread and had moderate to high flame lengths. The most active fire behavior would be experienced along the riparian drainage. Torching of individual or groups of trees is also predicted. Some embering causing spot fires ahead of the main fire would also be expected. The east flanks of the Thomas Road ignition point do not reach Foresthill Road even after four hours. The Blackhawk Road ignition is modeled as a line of fire, which explains the elongated shape. Ignitions on the divide are not predicted to cause large evacuations other than in the particular neighborhood where the fire is located. Again, it should be noted that the modeling does not account for man-made hazards such as home construction and other infrastructure that can influence evacuation times or suppression efforts.

The four ignitions on the east side of the Plan Area show the most active fire behavior. These fires have very fast rates of spread and long flame lengths. Fires in this area are burning primarily in chaparral vegetation on steep slopes. There is active crown fire predicted and heavy ember cast causing spotting ahead of the main fire. The fire's rate of spread would likely be reduced as it crests the ridge and burns into the mixed conifer forest.

The Todd Valley/Gas Canyon ignition is predicted to reach McKeon Ponderosa Way on the canyon rim after three hours but does not reach the majority of the homes in Todd Valley even after four hours. The main fire reaches Foresthill Road and Shady Oak Drive after four hours as well. The TUA analysis (#3) predicts much less time to reach the rim. Given the spotting ahead of the main fire, it is possible that Foresthill Road could be impacted within an hour, as could Todd Valley; however, the rate of spread on the Divide would be reduced to less than a ¼ mile an hour. This should allow enough time for residents to reach the primary evacuation centers to the northeast. Evacuating southwest on Foresthill Road is not recommended, as spots could roll further downslope and then burn back up the steep slopes towards the road.

The Todd Valley/CAL 2 ignition reaches approximately ¼ to ½ mile below Todd Valley Road and Patent Road after four hours and does not impact any communities. This should provide enough time to evacuate to the southwest on Foresthill Road.

The High School/Baltimore Mine ignition reaches approximately ½ mile from the nearest home and Baltimore Mine Road after four hours. It does not impact any communities, and it is approximately ¾ mile from Foresthill Road and the High School. This should allow enough time to evacuate to the southwest on Foresthill Road.

The Michigan Bluff/Circle Bridge ignition reaches approximately ⅓ to ½ mile from Michigan Bluff and Gorman Ranch Road after four hours. Both Gorman Ranch Road and Mosquito Ridge Road would be at risk from rolling debris that could start another fire that could run up one of the steep canyon drainages to the southwest. Enough time should be present to allow evacuation to the southwest on Foresthill Road.

Basing all decisions on this series of ignitions is not recommended, as a fire might start anywhere along the canyon slope and change the times of arrival. It is critical that the incident commander make these calls during the incident based on current and predicted fire behavior.

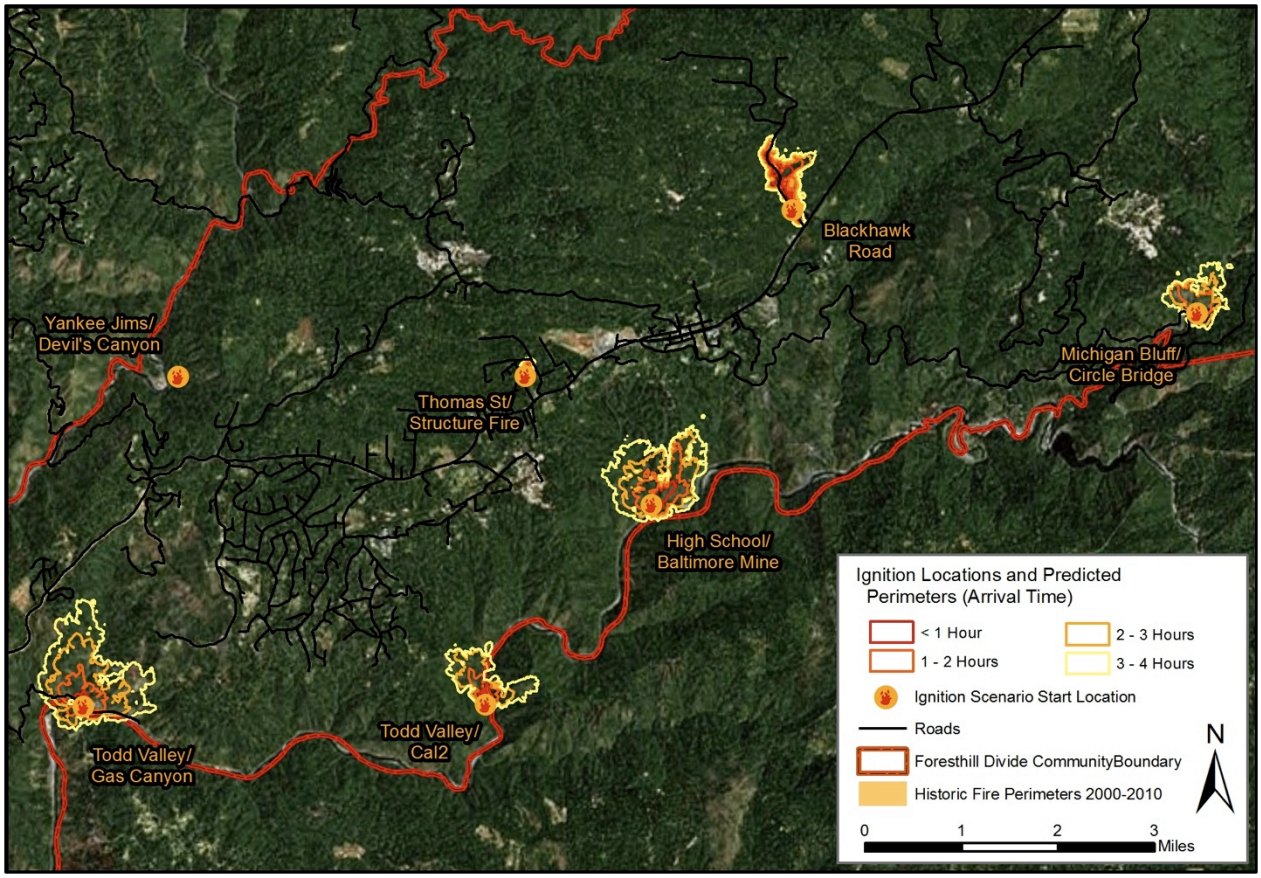

Figure 4. Ignition locations and predicted perimeters of fires after burning for four hours without suppression.

Analysis 3: ArcGIS/FlamMap

The time until arrival map (TUA) ™ shows the time it would take a fire to reach a specified values at risk. Rate of spread predictions are the underlying input to calculate arrival times. Each point on the map, represented by the colors in the legend, has an arrival time associated with it that represents the fastest route that a fire could reach the community of concern. This method may represent an overestimation of arrival times (quicker than actual) due to assumptions inherent in the modeling software. The TUA analysis is new and is only used as a support tool for the other analyses.

The values at risk chosen were the communities of Foresthill, Michigan Bluff, and Todd Valley. Foresthill Road was chosen since it is the primary evacuation route. Specific analysis of every point potentially affected is not feasible, but general interpretations of the outputs are discussed below.

Foresthill (community)

An ignition from most points along the Middle Fork of the American River would take 3-4 hours to reach this community. The TOA maps support this as well. This predicts that it would take 8+ hours for a fire from Todd Valley to reach any of the designated school evacuation centers. It can be expected that suppression actions would be taken within an hour and therefore it is unlikely the fire would reach the community.

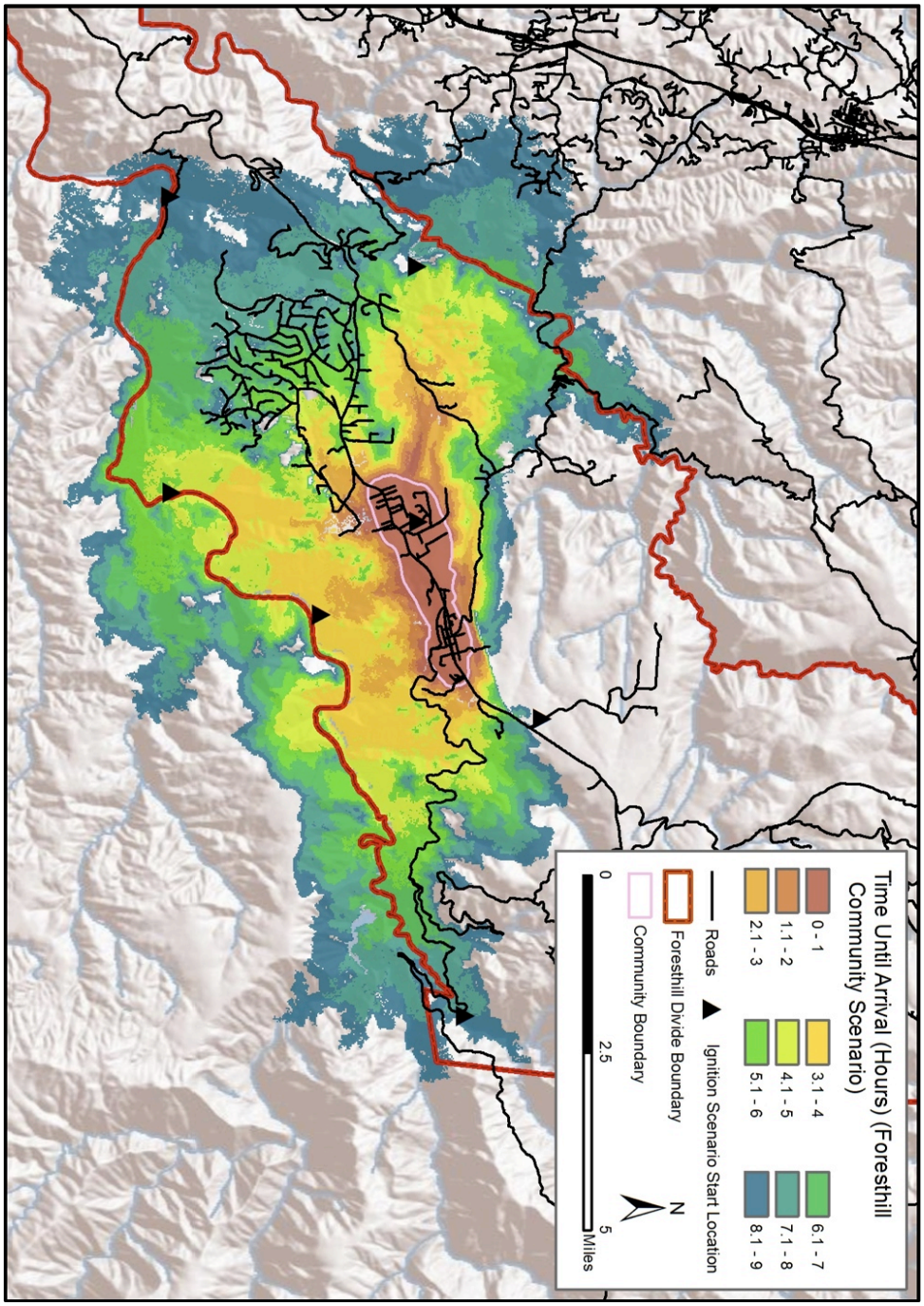

Figure 5. Time until arrival to Foresthill (community).

Michigan Bluff

Fires from most points along the Middle Fork of the American River would take 3-4 hours to reach this community. There is little threat from a fire along or west of Foresthill Road. As a result, evacuation is not needed, but if it was, residents would have ample time to leave.

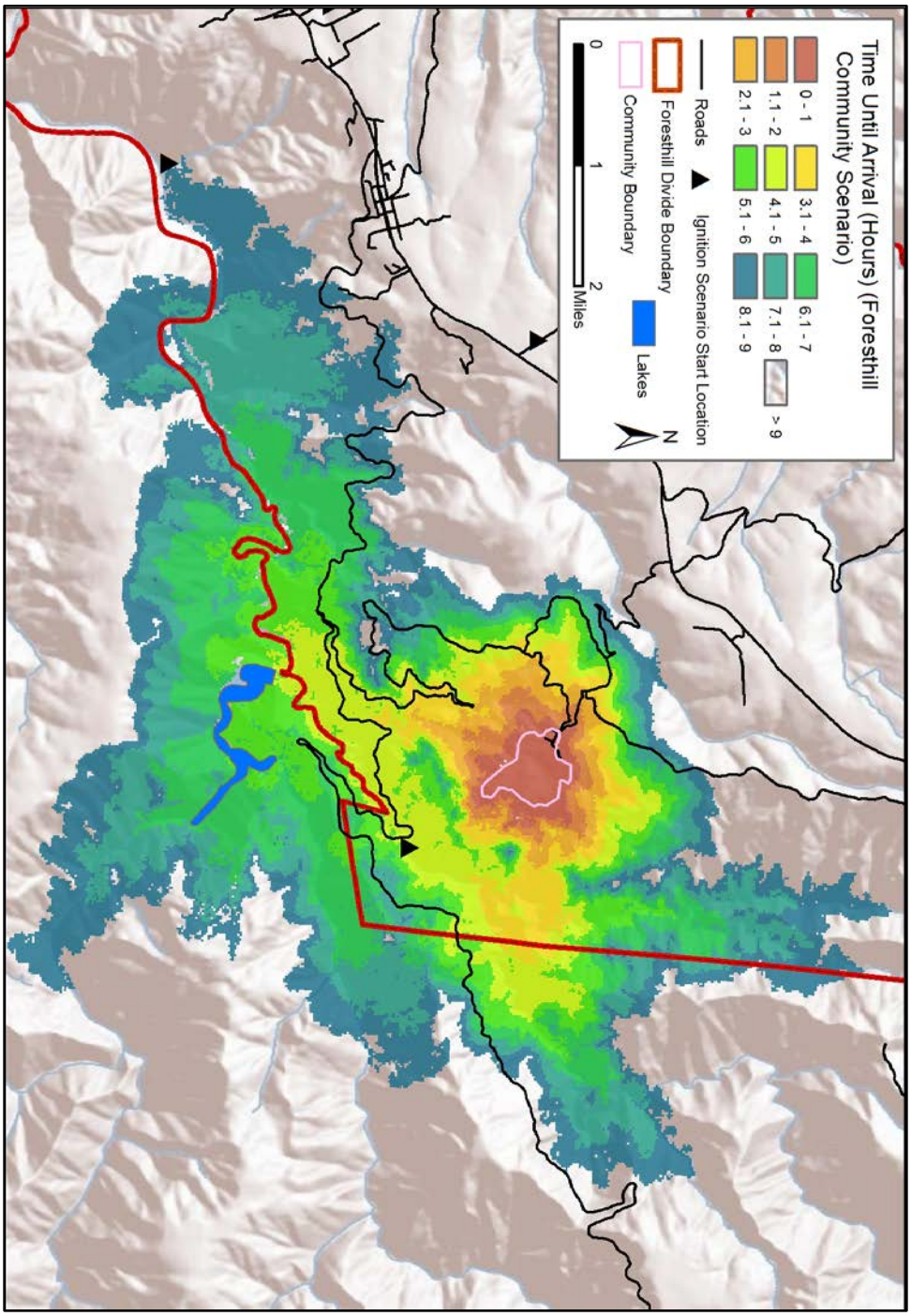

Figure 6. Time until arrival to Michigan Bluff.

Todd Valley

Fires from most points along the Middle Fork of the American River would take 1-2 hours to reach this community. It would take two hours from the Drivers Flat Road. This is supported by the TOA analysis. There is little chance of a fire in the Spring Garden/Yankee Jims Road reaching this community.

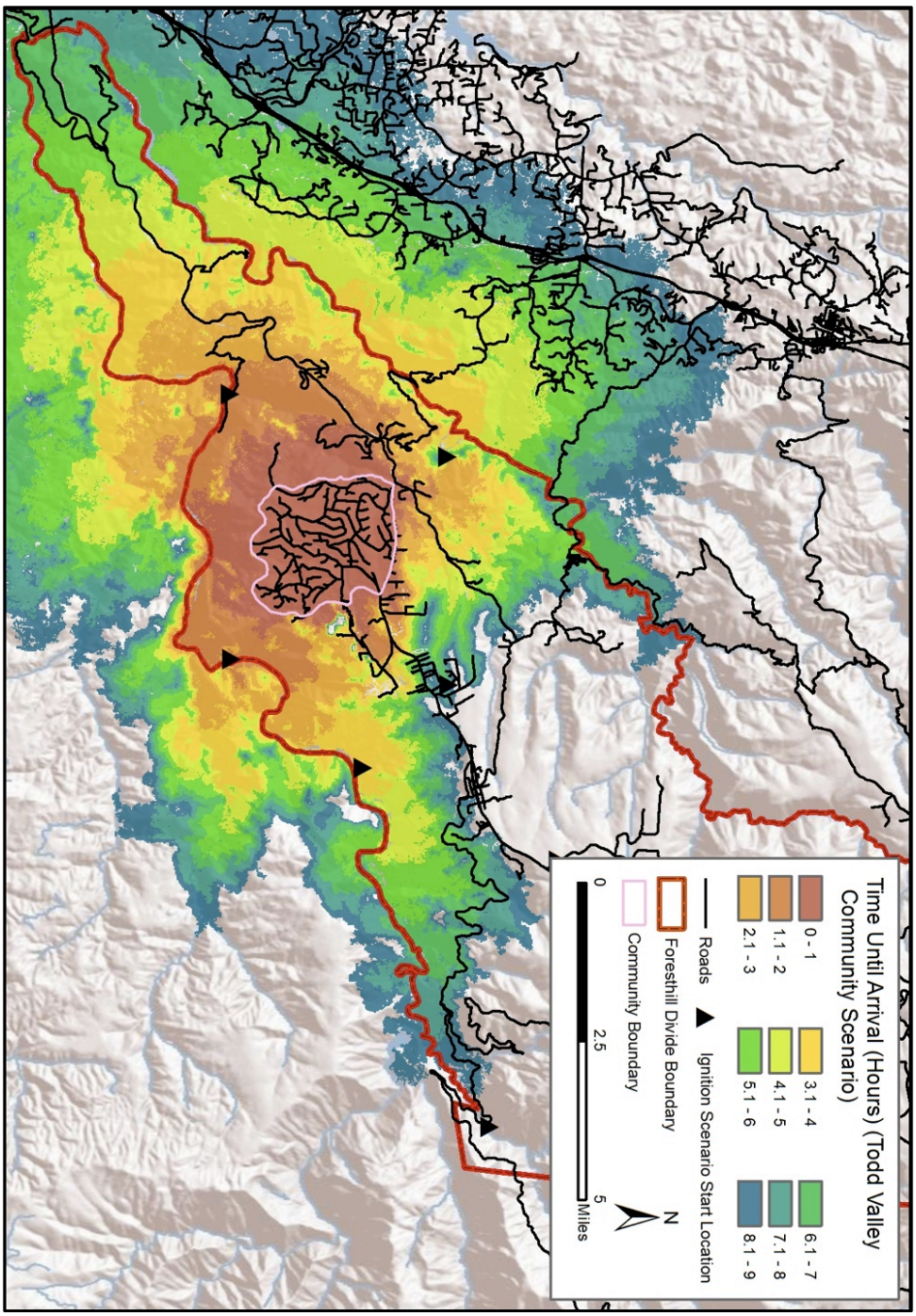

Figure 7. Time until arrival to Todd Valley.

Foresthill Road

Fires from most points along the Middle Fork of the American River would take 6+ hours to reach the road on the northeast end of the study area, beginning at Foresthill and going north through the town of Foresthill. Fires from the North fork of the American River would take over eight hours to impact the road. There is little threat and sufficient time to evacuate communities. As the road descends southwest, the TUA is decreased to an hour from the intersection of Moshiron Drive and Ponderosa Way. It is not surprising that the largest threat from fire is in the lower elevations where there are open mixed scrub/chaparral stands. This is supported by all the other analysis as well. It would not be recommended to drive down Foresthill Road if there was a fire below this intersection given these extreme conditions. This also further supports the recommendation that the Todd Valley community and others in the lower Divide evacuate northeast to the evacuation centers rather than to the south west.

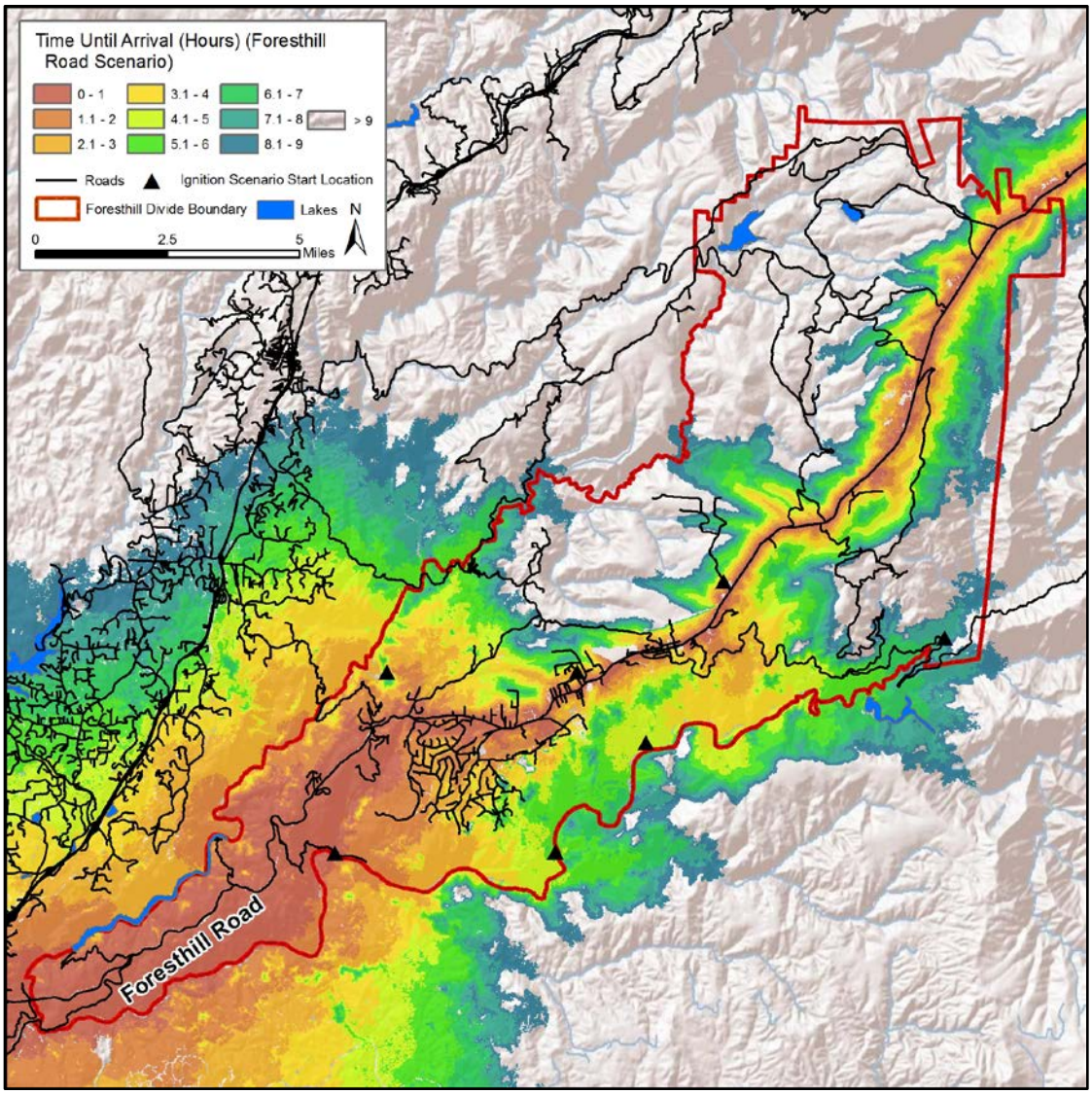

Figure 8. Time until arrival to Foresthill Road.

EVALUATION & IMPROVEMENT OF EXISTING PLANS

As part of this study, existing emergency and land use plans were evaluated to determine if they adequately addressed evacuation planning and the needs of the community in the event of a wildland fire. A multitude of plans exist at various scales, including the county-level to the fire district level. Descriptions of the plans and ways they can be improved are detailed within this section.

LOCAL HAZARD MITIGATION PLAN

The Local Hazard Mitigation Plan (LHMP) is a county-level plan, which includes 15 additional Annexes that address smaller geographical areas within Placer County. This plan is required and must be updated every five years for Placer County to remain eligible for federal disaster mitigation funding. The goal of the plan is to reduce the damages from natural emergencies, including flooding, earthquakes, and other severe weather, not just wildfire.[4] Because of the scale of this plan and because it is not specific to wildfire, it should not be expected to address evacuation concerns of the communities within Foresthill Divide. It would not be appropriate to add language to this plan that is consistent with the level of detail provided by this assessment. Since multiple natural hazards are being addressed within the Annex, including evacuation routes and centers would likely make the document cumbersome and unusable.

FORESTHILL DIVIDE COMMUNITY PLAN

The Foresthill Divide Community Plan (FDCP) is written at a smaller scale, but does not address local hazards and mitigation. Instead, it consists of a community development, resource management, and transportation and circulation element. Overall, it is designed to address land-use and growth issues facing the community so they can plan over the next 20 years.[5] Since this is not a hazard and mitigation plan, there is no reason to add additional language regarding evacuation routes and centers, nor should it detail actions to mitigate wildfire risk. At this point, there is no reason to amend the existing plan.

COMMUNITY WILDFIRE PROTECTION PLAN

The only plan specific to wildfire is the Community Wildfire Protection Plan for the West Slope of the Sierra Nevada in Placer County. The CWPP was completed in March 2008. While specific to wildfire, the document includes three Fire Safe Councils: Foresthill/Iowa Hill FSC, Greater Auburn Area FSC, and Placer Sierra FSC.[6] The level of detail in this plan is more than adequate for the geographical region is covers; however, adding more detail would further complicate the document. Since the document adheres to the Healthy Forests Restoration Act (2003), it includes details on fuel treatments, summarized below. The existing fuel breaks can be seen in Figure 9.

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[4] "Local Hazard Mitigation Plan," 8 June 2011. <http://www.placer.ca.gov/Departments/CEO/Emergency/Final%20Hazard%20Mitigation%20Plan.aspx>

[5] "Foresthill Divide Community Plan," 8 June 2011. <http://www.placer.ca.gov/Departments/CommunityDevelopment/Planning/CommPlans/FDCP.aspx>

[6] "Community Wildfire Protection Plan for the West Slope of the Sierra Nevada in Placer County. 8 June 2011. <http://www.placerfirealliance.org/Documents/CWPP%20Final.pdf>

Fuel Treatments

As identified in the CWPP for the West Slope of the Sierra Nevada in Placer County document, the Foresthill/ Iowa Hill Fire Safe Council has been working on projects since 1998. In addition to the 3,200 acres that have already been treated, the CWPP proposes 775 additional acres of fuels reduction projects. Descriptions of three of the projects are found below. For specific information on the all of the fuel projects and locations identified, see pages 4-3 through 4-6 in the CWPP document.

Finning Mill Road, Pipeline, and Todd Valley Shaded Fuel Breaks

The Finning Mill fuel break is along Finning Mill Road, north of Foresthill. The vegetation along Finning Mill has been thinned 150' on either side of the road, creating a 300' shaded fuel break. Because this project is anchored into a road, it is even more effective as a place to begin suppression tactics, like air operations. Other work associated with Finning Mill includes 300' fuel breaks along several ridges. There is a 10-year maintenance plan, which is being conducted by the private landowner.

Todd Valley represents the most concentrated residential development in the wildland/urban interface in the county. The 35,000 acre Auburn State Recreation Area (ASRA) provides recreational opportunities to over 900,000 visitors per year. With increasing use comes the potential for an increase of human caused fires. According to the Cal Fire (formerly CDF), ASRA was the source of 125 ignitions in the period 1990-2005. To help mitigate this risk, the pipeline and Todd Valley shaded fuel breaks have been completed. The result of this project is a 137 acre modified shaded fuel break: a defensible location to be used by fire suppression resources in the control of oncoming wildfires and prevent wildfire spread by removing hazardous fuels in a tactical area. The fuel break between the ASRA and these communities protects residents and property from wildfire originating in the ASRA and the ASRA from wildfire originating in the communities. The shaded fuel break is constructed on private lands adjacent to Bureau of Land Management (BLM), Bureau of Reclamation (BOR) lands and U.S. Forest Service Tahoe National Forest (USFS) lands. A large percentage of the property owners on these private lands have been in full support of the project as documented by their participation in the Fire Safe Council survey and public meetings associated with the planning processes.

The treatment prescriptions, found within the grant write-ups, are similar for all of these projects: vegetation modification comes from reducing the fuels from the lowest canopy layers to recreate a forest with old-growth characteristics. Trees 10 inches and larger at breast height have been left, while smaller trees were removed. Some saplings were left with 20'x20' or 30'x30' spacing. All shrubs were removed in the understory. A track masticator was used to chip/mulch small trees and shrubs. The trees that were left were pruned to a height of 12', with no more than 50% of the live crown removed.

Additions to these projects have been proposed, but are not occurring at the time of this report. When funding is secured, the Foresthill Fire Safe Council is planning on executing the additional work.

Federal Fuels Treatments

Federal fuels reduction project are occurring throughout the study area. The majority of these projects are north east of Foresthill and Michigan Bluff, since this is where the Forest Service owns property. Additional work is being done to the west of Michigan Bluff. Prescriptions for the projects are similar to the shaded fuel breaks described above, but often include burning as well. Understory vegetation is cut and chipped, and a low-intensity prescribed fire is frequently used to remove additional surface fuels.

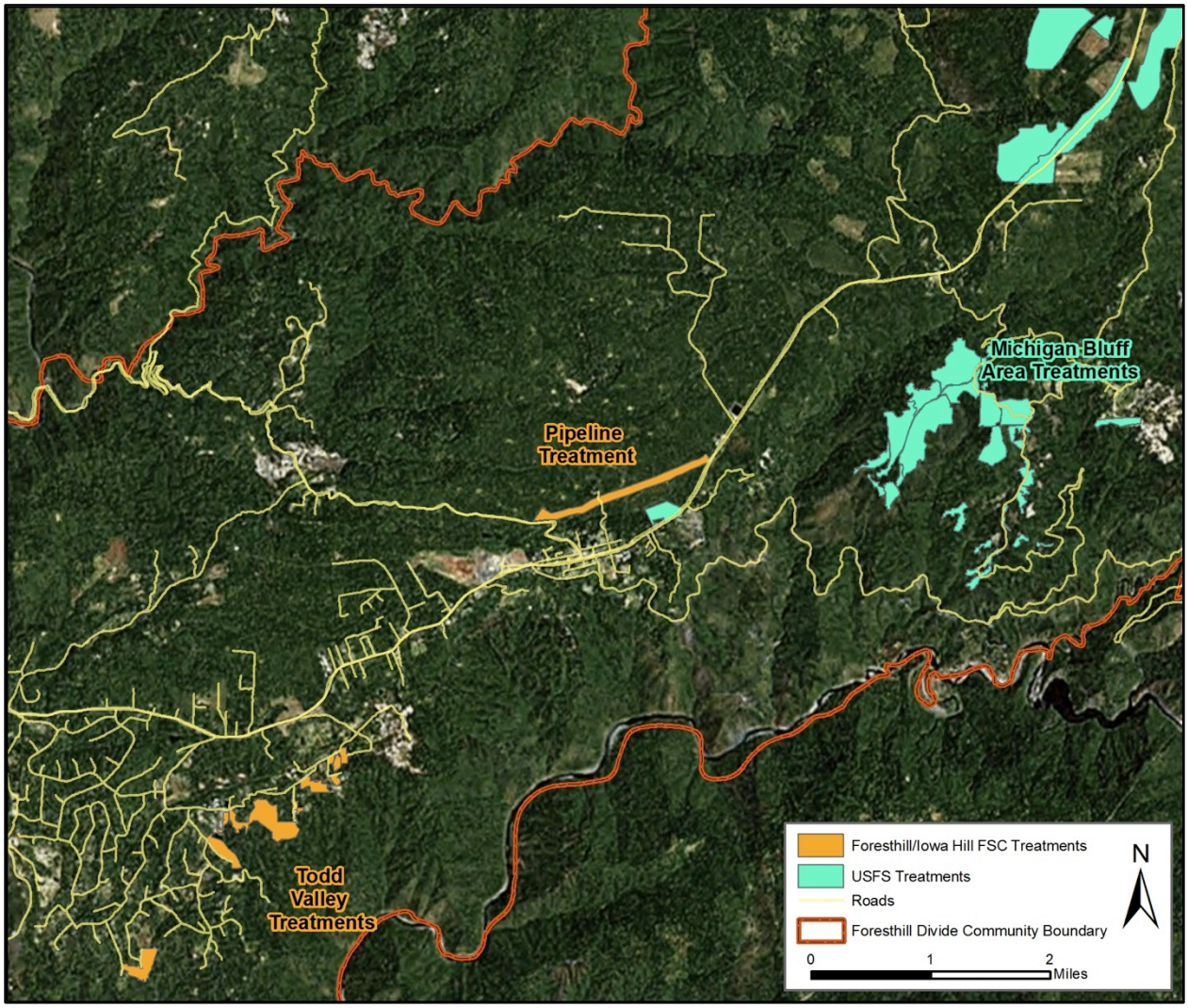

Figure 9. Existing fuel treatments within the Foresthill Divide Plan Area.

Although the part of the CWPP specific to the Foresthill Iowa Hill FSC has details on fuel reduction projects and risks associated with the area, no fire behavior modeling was done exclusively for the Foresthill Divide/Iowa Hill Divide. Furthermore, the scale at which the fuels and fire susceptibility were modeled is not fine enough to address the adequacy of existing evacuation routes, nor were evacuation issues mentioned in the plan. When the plan is revised, language that speaks to the lack of secondary evacuation routes, as well as updated information on existing and completed fuel breaks, and additional work that will be done within the Foresthill/Iowa Hill Divide FSC responsibility area should be added.

If adding this information makes the document unwieldy, consider creating a standalone document that details the work only for the Foresthill/Iowa Hill Divide FSC. See the Additional Recommendations section within this report for details on what information to include in such a document.

FORESTHILL DIVIDE/IOWA HILL DIVIDE EMERGENCY PLAN

Of all of the plans evaluated, the Foresthill Divide/Iowa Hill Divide Emergency Plan was written at the most appropriate scale to address the community's concerns. Specific areas of interest are addressed, including evacuation planning within Todd Valley and evacuation centers for the entire plan area.

Evacuation Routes

There has been little specific evacuation planning done in the study area, with the exception of Todd Valley. Overall, information on evacuation for the area is vague, and the Foresthill Divide and Iowa Hill Divide Emergency Plan states, "In Unified Command, the decision to evacuate or to prioritize evacuations is made after consultation between discipline (fire and law) ICs. Placer County Sheriff's Office (PCSO), working with the other agencies at the ICP or the EOC, executes the actual evacuation(s)." There are references made to predetermined "evacuation zones", but these are not further discussed in the plan.

California Highway Patrol (CHP) is responsible for traffic control in the event of a wildfire, after the IC has established evacuation priorities. The primary surface streets and roads are what comprise the main evacuation routes. Depending on where the fire starts and the direction it is traveling, the IC and CHP are tasked with identifying, which evacuation routes are viable and what areas need to be evacuated, if any.

This plan identifies evacuation planning that has occurred in the Todd Valley Community, including the actual routes of travel to be taken within the community. In addition to being identified on a map, there are large signs with the letter 'E' and an arrow, directing residents out of the sub-division. Eight evacuation zones within Todd Valley have been determined, and fire roads listed as "limited access" have been mapped.

Foresthill Road is the primary evacuation route for residents in the area. After discussion with local firefighters and residents, it was determined that none of the following roads were adequate evacuation routes: Finning Mill Road, Ponderosa Way, Spring Garden Road, and Yankee Jims Road. Fire modeling, in combination with road conditions, reveal the danger of using Mosquito Ridge Road, Gorman Ranch Road, Drivers Flat Road, McKeon Ponderosa Way and others to the east, if there was a fire below. These roads are typically one-lane, dirt, have grades greater than 15%, may require 4-wheel drive vehicles, have extremely steep slopes on either side, and require crossing unrated and/or condemned bridges. While local authorities are familiar with the quality of these roads, incoming resources are not. Information regarding the hazards relating to the inadequate roads should be identified in the plan so incoming resources, including fire and law enforcement, know to not send residents or emergency apparatus down these paths.

Another issue to consider when discussing evacuation within the existing plan is the high number of elderly, disabled, and low-income individuals who may not have transportation during an evacuation. No mention is made as to how this issue will be handled in the case of a wildfire emergency. More detailed information as to how these members of the population will be accommodated is necessary within the plan.

Evacuation Centers

Eight evacuation sites have been identified in the Community Plan. They include: Canyon View Assembly of God, Calvary Bible Church, the Church of Latter Day Saints, Foresthill Elementary and Middle Schools, Foresthill Memorial Hall, and the Old Georgia Pacific Mill/Foresthill High School area. Of these centers, the schools have large irrigated fields surrounding them and are built with more fire resistant construction. The Old Georgia Pacific Mill and high school are directly adjacent to one another, thus creating the largest evacuation area in the study area. The churches and memorial hall do not have the same amount of vegetation clearing around them, or the same construction type that provide for protection from flames and embers. Because of these differences, they are intended to be used as meeting places for residents; the intent is to ensure families are together before potentially having to evacuate. Overnight housing, including food and water, is not the objective of these locations. The schools and the Old Georgia Pacific Mill are able to provide shelter for displaced residents. While they currently do not have adequate supplies to support residents, with the assistance of the Red Cross, the goal is to be able to provide shelter for 24 to 48 hours. The details of these plans, including analysis of the buildings, are available from the Foresthill Fire Protection District and from the Auburn Red Cross, but the information is not published in any formal plan.

Evacuation sites being used for fire equipment are a concern to the residents in the study area. Upon evaluation, it was found that during the American River Complex, the old mill site was used as an incident command post (ICP). Since the fire was 11 miles away from Foresthill, the area was not needed for an evacuation center.

Although the evacuation centers are identified in the Foresthill Divide/Iowa Hill Divide Emergency Plan, there are no details on what should be expected from each center. Not every building is adequate for sheltering-in-place, and residents should not expect to get supplies from these places. Other centers are capable of housing people for 24-48 hours, but again, there are no details regarding this information in the plan.

ADDITIONAL RECOMMENDATIONS

CREATE A WILDFIRE PLAN EXPLICIT TO FORESTHILL DIVIDE

Following the examination of the existing plans pertaining to Foresthill Divide, it has been determined that there are not many changes that are required of these documents. The issue is that the additional detailed information desired by residents and fire personnel do not belong in any of the existing plans, either because of scale or intent. All-hazard plans address too large a variety of potential hazards to be able to focus on wildfire issues specifically. Operational tactics for a flood are different than for a wildfire, and it is difficult for a countywide all-hazard plan to adequately address the differences within a single plan. The limitations of existing plans can be resolved by creating a wildfire-specific document, such as a CWPP, that will tackle concerns like evacuation routes, evacuation centers, detailed fuel projects, and actions that can be taken by individual homeowners. The information and analysis that is being requested by the residents of Foresthill Divide fits within the context of a wildfire plan or CWPP.

The biggest concern to the majority of residents is the safety of their families and themselves, so knowing when and how they should be evacuated needs to be a primary focus of a wildfire plan. There are NOT viable secondary evacuation options to the west or east. The most effective way to mitigate this risk is to critically evaluate whether evacuations are necessary. For many of the fire scenarios presented in this study, evacuating residents is not essential, and doing so may actually put them at a greater risk. If required, aggressive fuels treatments along Foresthill Road and specifically the lower portion of the road are the most proactive approach to creating a safe evacuation route out of Foresthill Divide. Fuels reductions on either side of the road will do more to protect residents who are evacuating and incoming emergency crews during a wildland fire than anything else. When considering future growth, it is unlikely that additional vehicle pullouts or lanes will be more effective at providing a safe way out compared to thinning and maintaining fuels reduction along the sides of the road. They will most certainly be more cost-effective than widening the road. The east side of the plan area along the top rim of the canyon is another area that should be considered for fuel treatments. Reducing the fuel load where the fire behavior is most extreme along the ridge line would be beneficial in diminishing the rates of spread and flame lengths. This would also provide firefighters with anchor points to begin their suppression efforts or serve as a target for air tanker drops. Currently there are plans to extend several of the shaded fuel breaks around Foresthill and Todd Valley. Using the fire behavior modeling done for this study, further evaluation and extension of these projects will act to further protect values at risk from wildfire. Existing treatments around Todd Valley, identified in the CWPP, should be considered a priority. These treatments should be further evaluated to determine sections where it would be beneficial to widen the 300’ area or remove more trees than stated in the existing prescriptions. Exact locations and prescriptions of where efforts should be focused are aspects of a detailed wildfire plan.

Defensible space for all evacuation sites is the most important action that can be taken to create safe evacuation centers/safety zones. Detailed information on how to create defensible space is also an aspect of a wildfire plan, and each center should be analyzed in-depth in an appropriately scaled fire plan. Removing fuels around these buildings will minimize the potential of direct flame impingement or of ember-cast causing structure loss. Following defensible space, actions to reduce structural ignitability are the next important action. Installing screens over vents, having double-pane windows, using fire resistant construction materials like stucco, cement, and

having Class A roofing materials are all features that will help protect all structures, not just designated evacuation centers. It is important to understand that buildings could ignite from embers some distance away, but if the safety zone is adequate it could be patrolled and any ignition extinguished. It is recommended to turn on lawn sprinklers and commit at least one engine crew to patrol and maintain communication. See the CAL FIRE document *General Guidelines for Creating Defensible Space* to learn about the details on how to reduce the flammability of structures. If the correct mitigation measures are taken, all of the sites identified have the potential to serve the Foresthill community at some level. A wildfire plan would not only address structural ignitability, but it could also clarify what sites residents should go to, and whether the site was intended as a meeting site or actual shelter for an extended period.

To adequately address the concerns of the residents in Foresthill Divide, an additional document needs to be put together that speaks solely to wildfire and at a scale that is applicable for their needs. Residents need to know whether or not to evacuate if there is a fire, and if so, where to meet their family or where to go for long-term support. Community participation during the process will ensure that all concerns are addressed. Preparedness planning at this scale can help reduce panic during a confusing and stressful situation, creating a safer environment for residents and emergency service providers.

PUBLIC EDUCATION

One of the most valuable actions that can reduce the threat of wildfire is to educate the public on fire safety and current fire danger. The following recommendations should be implemented or maintained if already in place. Since the area around Foresthill has such a high quantity of public lands, putting up fire danger signs along Foresthill Road and along other roads that lead into the National Forests is an initial step to creating awareness. In addition to fire danger signs, posting flyers in local businesses and at campsites with fire safety tips are ways to raise public awareness regarding wildfire. Firefighters should be equipped with pamphlets that they can hand out to campers and other recreationalists in the study area. Increased presence of rangers or firefighters, and the opportunity to become educated on wildfire prevention should minimize the number of human-caused ignition that pose one of the greatest risks to residents in Foresthill, Todd Valley, and Michigan Bluff.

All of the actions mentioned in the additional recommendations section of this report are items that would be valuable to include in a wildfire plan or CWPP. Incorporating these recommendations and analyses into a single document would be one of the greatest benefits to both residents and fire officials in Foresthill Divide.

Recommendations in this document are not prescriptive, but are intended to assist in the identification of possible solutions or mitigation actions to reduce the impact of wildfire on values at risk. The views and conclusions in this document are those of the authors and should not be interpreted as representing the opinions or policies of any governmental entity or fire agency, signatory companies, Placer County or the United States Government. The methodology used is proprietary and as such may not match with other existing hazard and risk ratings. In the event the language of this document conflicts with any regulatory documents, policies, or local laws, this document does not supersede any regulatory documents, local laws, or policies.

METHODOLOGY APPENDIX

Three different modeling techniques were used to test the efficacy of evacuation plans and routes. Each of the models is described below using the direct language from their associated websites.

The **FlamMap** fire mapping and analysis system (Finney 2006; Stratton 2006) is a PC-based program that describes potential fire behavior for constant environmental conditions (weather and fuel moisture). Fire behavior is calculated for each pixel within the landscape file independently, so FlamMap does not calculate fire spread across a landscape. Potential fire behavior calculations include surface fire spread (Rothermel 1972), crown fire initiation (Van Wagner 1977), and crown fire spread (Rothermel 1991). Dead fuel moisture is calculated using the Nelson model (Nelson 2000) and FlamMap permits conditioning of dead fuels in each pixel based on slope, shading, elevation, aspect, and weather.

Because environmental conditions remain constant, FlamMap will not simulate temporal variations in fire behavior caused by weather and diurnal fluctuations as FARSITE does. Nor will it display spatial variations caused by backing or flanking fire behavior. These limitations need to be considered when viewing FlamMap output in an absolute rather than relative sense. However, outputs are well-suited for landscape level comparisons of fuel treatment effectiveness because fuel is the only variable that changes. Outputs and comparisons can be used to identify combinations of hazardous fuel and topography, aiding in prioritizing fuel treatments.[7]

FARSITE (Fire Area Simulator) is a model for spatially and temporally simulating the spread and behavior of fires under conditions of heterogeneous terrain, fuels, and weather. It uses existing fire behavior models for surface fire spread (Rothermel 1972), crown fire initiation (Van Wagner 1977), and crown fire spread (Rothermel 1991), post-frontal combustion (Albini and others 1995; Albini and Reinhardt 1995), and dead fuel moisture (Nelson 2000).[8]

Seven ignition points were modeled under the extreme fire weather parameters mentioned below. The fires were set to burn for four hours without any suppression activities. These ignitions were chosen because they are believed to be areas where recreational use may increase the probability of a fire start and/or because the values at risk threatened. The time of arrival (TOA) outputs were overlaid onto the landscape to show their predicted impact.

FireFamilyPlus is a comprehensive Windows-based program that analyzes and summarizes an integrated database of fire weather and fire occurrence. It combines the functionality of the programs PCFIRDAT, PCSEASON, FIRES, and CLIMATOLOGY. FFP can be used to calculate fire danger rating indices and components, summarize both fire and weather data, and offers options to jointly analyze fire and weather data. The program can display data, compute values, and statistically analyze data in graph or report form.

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[7] "FlamMap Overview," 8 June 2011, <http://www.firemodels.org/index.php/flammap-introduction/flammap-overview>

[8] "FARSITE Overview," 8 June 2011, <http://www.firemodels.org/index.php/farsite-introduction/farsite-overview>

Time Until Arrival ™

Based on rate of spread predictions, time until arrival maps show the time it would take a fire to spread to the NEAREST edge of a value at risk (community or road) assuming an ignition were to occur anywhere on the map. The analysis takes into account the possibility that the quickest route between an ignition and a value at risk may not be a straight line. It is, however, the fastest based on rate of spread predictions over the various potential paths between the values at risk and every cell on the map. This method may represent an overestimation of arrival times (quicker than actual) due to assumptions inherent in the modeling software. This over-estimation is an effort to err on the side of caution when pre-planning for potentially life-threatening situations.

Areas of concern in this study are either designated based on the presence of values at risk (i.e. Todd Valley, Foresthill, and Michigan Bluff) or on evacuation route concerns (i.e. Foresthill Road).

Modeling Limitations and Discussion

All models have assumptions and limitations. Modeling results should always be used with caution and with as much understanding of the weaknesses as possible. Only trained individuals should interpret the outputs for best results.

Weather conditions are extremely variable and all possible combinations cannot be accounted for. These outputs are best used for pre-planning and not as a stand-alone product for tactical planning. Whenever possible, fire behavior calculations should be done with actual weather observations during the fire. The most current Energy Release Component (ERC) values should also be calculated and distributed during the fire season to be used as a guideline for fire behavior potential.

Crown fire activity, rate of spread, flame length and time until arrival are derived from the fire behavior predictions. A limitation of FlamMap is that crown fire is not calculated for shrub models. The best method of determining the probability of crown fire in shrubs is to look at the flame length outputs and assume that if the flame length is greater than ½ the height of the plant, it will likely torch and/or crown.

REFERENCE WEATHER USED IN THE POTENTIAL FIRE BEHAVIOR EVALUATION

Climate and fuel moisture inputs for FlamMap were created by using data collected from a Remote Automated Weather Station (RAWS). The Pilot Hill RAWS was used to capture the climate for the project. Although it is some distance from the study area it is representative for fires in the valley and would capture the most extreme conditions possible.

Latitude (dd.ddddd)	**38.8317º N**
Longitude (dd.ddddd)	**121.009º W**
Elevation (feet)	**1249**

Table 3. Pilot Hill RAWS (42609) information.

Weather conditions found during the 49 Fire or Auburn fire were used to capture an extreme fire day (in terms of fuel moistures).This fire began on August 30, 2009 and was representative of a worst-case scenario. The modeling software was initial calibrated using these weather conditions and the perimeter of this fire.

Extreme Weather Conditions	
Variable	**Value**
*20 ft Wind Speed Upslope	20
**Herbaceous Fuel Moisture	30
**Woody Fuel Moisture	60
1-hr Fuel Moisture	2
10-hr Fuel Moisture	3
100-hr Fuel Moisture	5

Table 4. Input wind and fuel moisture parameters from FireFamilyPlus used for fire behavior models

***Winds blowing uphill.
**Live fuel moistures are not calculated accurately from RAWS, so a standard extreme fuel moisture set was used for live woody fuel moisture and live herbaceous fuel moisture. For standard values, see Scott and Burgan pg. 18 (2005).[9]

Winds

Upslope winds were used instead of directional winds for the FARSITE and FlamMap scenarios because aligning slope and wind will give the worst-case results. Directional winds would favor one aspect over another and would show lower fire behavior on the leeward aspects.

[9] Scott, J.H. and R. Burgan. 2005. *Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model*, United States Department of Agriculture Forest Service, RMRS-GTR-153.

Dead Fuel Moisture

Dead fuel moisture responds solely to ambient environmental conditions and is critical in determining fire potential. Dead fuel moistures are classed by timelag. A fuel's timelag is proportional to its diameter and is loosely defined as the time it takes a fuel particle to reach two-thirds of its way to equilibrium with its local environment. Dead fuels in the National Fire Danger Rating System (NFDRS) fall into four classes: 1, 10, 100, and 1000 hour.[10]

Pre-conditioning of fuel moistures was calculated for this scenario. The models calculate separate dead fuel moistures for each landscape cell based on the topography and shading from forest canopy cover and clouds, as well as the recorded weather (precipitation, high and low temperatures and high and low relative humidity values) for the previous four days. The dead fuel moistures that have been calculated by the start date and time of the analysis are what are used to determine the outputs in fire behavior models.

Live Fuel Moisture

Live fuel moisture is the amount of water in a fuel, expressed as a percent of the oven-dry weight of that fuel. Fuel moisture between 300% and 30% is considered live. Anything below 30% is considered dead fuel. Fuel moistures can exceed 100% because the living cells can expand beyond their normal size to hold more water when available.

Landscape File Layers

A landscape file (.LCP) is a series of spatial layers that are required to run FARSITE and FlamMap. The following layers were downloaded from LANDFIRE Version 1.1.0: [11]

Elevation
Crown Bulk Density
Aspect
Crown Base Height
Slope
Stand Height
Fuel Model[12]
Duff Loading
Canopy Cover
Coarse Woody

[10] U.S. National Fire Danger Rating System Overview: INT-GTR-367 - FIRES: Fire Information Retrieval and Evaluation System - a Program for Fire Danger Rating Analysis

[11] "LANDFIRE," 8 June 2011, <www.landfire.gov>

[12] Scott and Burgan's *Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model*, a national standard guide to fuel modeling.

Fuel Models are a critical component to the modeling. Often some changes need to be made to more accurately represent local conditions. The following changes were made to the LCP:

- Fuel model 183 was converted to fuel model 147.
- Fuel treatment polygons such as the Todd Valley treatments and the pipeline treatment, the underlying fuel models were converted to fuel model 181 and the crown base height was raised to six feet.
- The evacuation centers were set to fuel model 99.

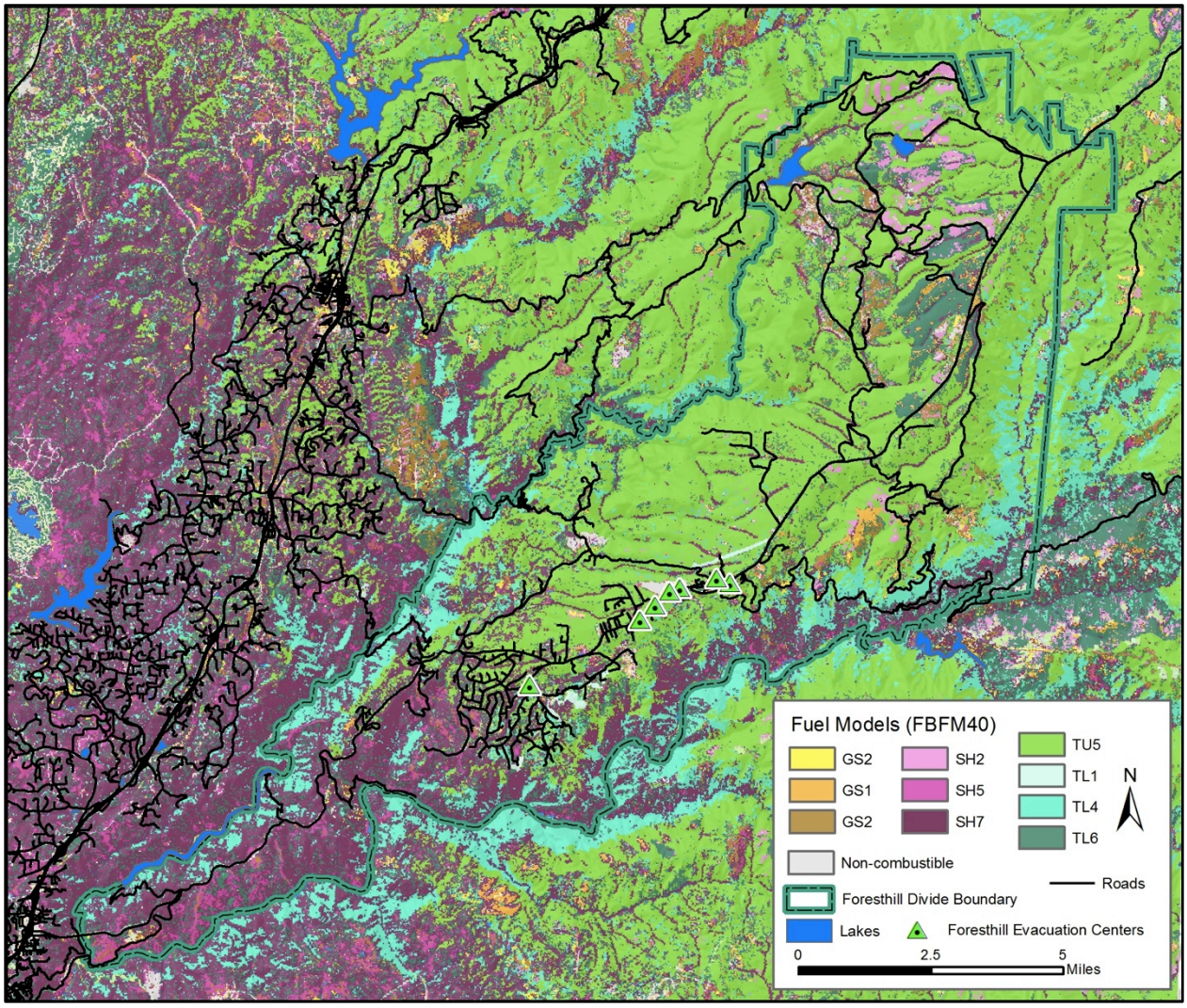

Figure 10. Fuel models present in the Plan Area.